

1     CLAIMS:

2             1.     A method of bonding solder balls to bond pads on a  
3     substrate comprising:

4                 contemporaneously retaining at least two solder balls over different  
5     respective bond pads on a substrate in the absence of flux; and

6                 with said balls so retained, exposing the balls to bonding  
7     conditions effective to bond the balls with their associated bond pads.

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9             2.     The method of claim 1, wherein the exposing of the balls  
10    comprises laser-bonding the balls.

11  
12            3.     A method of bonding solder balls to bond pads on a  
13    substrate comprising:

14                placing at least portions of a plurality of solder balls within a  
15    frame and in registered alignment with individual bond pads over a  
16    substrate; and

17                while the ball portions are within the frame, exposing the balls  
18    to bonding conditions effective to bond the balls with their associated  
19    bond pads.

20  
21            4.     The method of bonding solder balls of claim 3, wherein said  
22    placing comprises placing individual solder balls within individual holes  
23    within the frame.

24

1           5.     The method of bonding solder balls of claim 3, wherein said  
2 placing comprises placing majority portions of individual solder balls  
3 within individual holes within the frame.

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5           6.     The method of bonding solder balls of claim 3, wherein said  
6 exposing comprises laser bonding the balls with their associated bond  
7 pads.

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9           7.     The method of bonding solder balls of claim 3, wherein said  
10 exposing comprises laser bonding the balls with their associated bond  
11 pads by fixing the position of the frame and moving a laser beam  
12 relative to the frame from ball-to-ball.

13  
14           8.     The method of bonding solder balls of claim 3, wherein said  
15 exposing comprises laser bonding the balls with their associated bond  
16 pads by fixing the position of a laser beam and moving the frame  
17 relative to the laser beam from ball-to-ball.

18  
19           9.     The method of bonding solder balls of claim 3 further  
20 comprising moving the frame away from the substrate.

21  
22           10.    The method of bonding solder balls of claim 3 further  
23 comprising after the exposing of the balls, moving the frame away from  
24 the substrate.

11. The method of bonding solder balls of claim 3, wherein:  
said placing comprises placing individual solder balls within  
individual holes within the frame; and

said exposing of the balls comprises reflowing the solder balls  
while the balls are within their individual holes, and further comprising  
after said reflowing removing the frame from around the reflowed balls.

12. The method of bonding solder balls of claim 3, wherein said  
placing comprises placing said ball portions on fluxless bond pad  
surfaces.

13. A method of bonding solder balls to bond pads on a  
substrate comprising:

providing a frame having a plurality of holes sized to receive  
individual solder balls;

delivering individual balls into the holes from over the frame;

placing the balls into registered alignment, while the balls are in  
the holes, with a plurality of individual bond pads over a substrate; and

bonding the balls with their individual associated bond pads.

14. The method of claim 13, wherein the holes are sized to  
receive a majority portion of an associated solder ball.

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1           15. The method of claim 13, wherein the holes are sized to  
2 receive a majority portion of only one associated solder ball.

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4           16. The method of claim 13, wherein said delivering of the  
5 individual balls comprises rolling at least one ball over a frame surface  
6 until the one ball drops into an associated hole.

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8           17. The method of claim 13, wherein said delivering of the  
9 individual balls comprises rolling a plurality of balls over a frame  
10 surface until individual balls drop into respective associated individual  
11 holes.

12  
13           18. The method of claim 13, wherein said placing of the balls  
14 into registered alignment comprises moving the frame to proximate the  
15 substrate before any of the balls are delivered into the holes.

16  
17           19. The method of claim 13, wherein said placing of the balls  
18 into registered alignment comprises moving the frame to proximate the  
19 substrate before any of the balls are delivered into the holes; and

20           said delivering of the individual balls comprises rolling a plurality  
21 of balls over a frame surface until individual balls drop into respective  
22 associated individual holes.

1           20. The method of claim 13, wherein the bonding of the balls  
2 comprises laser bonding the balls with their individual associated bond  
3 pads.

4  
5           21. The method of claim 13, wherein the bonding of the balls  
6 comprises laser bonding the balls with their individual associated bond  
7 pads by fixing the position of the frame and moving a laser beam  
8 relative to the frame from ball-to-ball.

9  
10          22. The method of claim 13, wherein the bonding of the balls  
11 comprises laser bonding the balls with their individual associated bond  
12 pads by fixing the position of a laser beam and moving the frame  
13 relative to the laser beam from ball-to-ball to effectuate the bonding.

23. A method of bonding solder balls to bond pads on a substrate comprising:

providing a frame having a plurality of holes;

inserting individual solder balls into the holes, the balls being small enough to pass through the holes;

placing the frame into proximity with a substrate having bond pads positioned thereon, more than one of the plurality of holes holding an individual solder ball therewithin and in registered alignment with an associated bond pad on the substrate;

laser-bonding the solder balls to their individual bond pad; and

after the laser bonding, removing the frame from proximity with the substrate.

24. The method of claim 23, wherein said inserting comprises inserting said balls from over the frame.

25. The method of claim 23, wherein said laser-bonding comprises moving a laser beam relative to and between individual solder balls.

26. The method of claim 23, wherein said laser-bonding comprises moving individual solder balls relative to a generally-fixed laser beam.

1 27. A method of bonding a solder ball to a bond pad on a  
2 substrate comprising:

3 providing a frame having a hole;

4 providing a solder ball having an outer surface;

5 retaining the solder ball within the hole in an ambient processing  
6 environment which is generally uniform over the entirety of the ball's  
7 outer surface; and

8 while the solder ball is within the hole, bonding the solder ball  
9 with an associated bond pad on a substrate.

10  
11 28. The method of claim 27, wherein the retaining of the solder  
12 ball comprises retaining at least a majority portion of said ball within  
13 the hole.

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15 29. The method of claim 27 further comprising inserting the ball  
16 into the hole from a position within said ambient processing  
17 environment.

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19 30. The method of claim 27, wherein the bonding of the solder  
20 ball comprises laser bonding said ball.

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1           31. A method of bonding solder balls to bond pads on a  
2 substrate comprising:

3           providing a surface having a plurality of holes therein;  
4           providing a plurality of solder balls over the surface;  
5           depositing some of the solder balls into at least some of the  
6 holes; and

7           bonding the solder balls which were deposited into the holes to  
8 individual associated bond pads positioned on a substrate proximate the  
9 holes.

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11           32. The method of claim 31, wherein the providing of the  
12 solder balls comprises rolling at least one ball over the surface and into  
13 a hole.

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15           33. The method of claim 31, wherein the providing of the  
16 solder balls comprises rolling a plurality of balls over the surface and  
17 into individual respective holes.

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19           34. The method of claim 31, wherein:  
20           each hole is dimensioned to receive only one ball; and  
21           the providing of the solder balls comprises rolling a plurality of  
22 balls over the surface and into individual respective holes.



1 35. The method of claim 31 further comprising removing any  
2 balls from over the surface which were not deposited into a hole.

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4 36. The method of claim 31, wherein the bonding of the balls  
5 comprises laser-bonding each ball to an individual bond pad.

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7 37. The method of claim 31, wherein the bonding of the balls  
8 comprises laser-bonding each ball to an individual bond pad by fixing  
9 the position of a laser beam and moving each ball into the path of the  
10 laser beam.

11  
12 38. The method of claim 31, wherein the bonding of the balls  
13 comprises laser-bonding each ball to an individual bond pad by moving  
14 a laser beam to engage each ball.

15  
16 39. A method of bonding solder balls to bond pads on a  
17 substrate comprising:

18 providing a surface having a plurality of holes therein;

19 providing more solder balls than there are holes over the surface;

20 moving the plurality of balls and the surface relative to one  
21 another effective to deposit one solder ball into each hole;

22 removing excess solder balls from over the surface; and

23 bonding the balls which were deposited into the holes to  
24 individual bond pads positioned on a substrate proximate the holes.

1           40. The method of claim 39, wherein the bonding of the balls  
2 comprises laser bonding the balls.

3  
4           41. The method of claim 39, wherein the bonding of the balls  
5 comprises laser bonding the balls by moving each ball into the path of  
6 a laser beam.

7  
8           42. A solder ball support apparatus comprising:  
9 a frame; and  
10 a plurality of ball-supporting features configured to maintain at  
11 least two solder balls in registered alignment with at least two different  
12 bond pads on a substrate.

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14           43. The solder ball support apparatus of claim 42, wherein the  
15 ball-supporting features comprise individual holes which extend through  
16 the frame.

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18           44. The solder ball support apparatus of claim 42, wherein the  
19 individual holes are dimensioned to receive only one solder ball at a  
20 time.